Distribution of a Generic Mission Planning and Scheduling Toolkit for Astronomical Spacecraft

Contract NAS5-32800

Final Progress Report

For the period 19 October 1994 through 18 October 2000

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This contract provided for the packaging and distribution of the planning and scheduling toolkit developed for the SWAS Submillimeter Wave Astronomy Satellite.

This work is complete and the planning and scheduling software is available for browsing and download at its own web site

http://www.quaternion.harvard.edu

The planning and scheduling software is a modular, flexible and full-featured system that includes:

- user-definable observing modes
- automatic guide star selection
- automatic waypoint generation and scheduling
- automatic scheduling of periodic instrument tests
- astrometric light travel time corrections and corrections for place for Solar System targets
- automatic ingestion of JPL Horizon ephemerides for small bodies
- automatic generation of planetary positions from the DE200 JPL ephemeris
- driven by a point-and-click graphical user interface
- automatic spacecraft ephemeris ingestion and processing

The planning and scheduling system has performed flawlessly in the last two and one-half years of SWAS operation.

The substantial code base notwithstanding, the SWAS system brings three significant items to the astronomical spacecraft planning and scheduling table:

1) It shows that by the proper choice of coordinate transformations the complex spherical trig calculations conventionally used can be made very simple and straightforward. Aside from the obvious benefit, this makes the spacecraft much safer. One can find, for example, scheduling algorithms that require checking for eight different cases, one for each of the octants of the cosmic sphere. The potential for a ruinous error is evident!

2) It shows that the simplest scheduling algorithms, for example scheduling an observation in the first available place, are very efficient and user-friendly. The products of a simple algorithm are understandable and predictable and a scheduler can anticipate

what will happen when modifying a schedule. More sophisticated algorithms produce only minimally more efficient schedules and are much harder to work with.

3) It provides a reference scheduling system for building other systems. This is a scheduling system built to be as simple as possible while still satisfying a complex set of scheduling requirements, and it is a system that has been proven to work extremely well.

Two additional related subsystems can be seen on the website and are also available for download:

The SWAS TACT -- Trending, Analysis and Correlation Tool -- is a web-based telemetry analysis tool used to monitor the health and performance of the spacecraft. The system waits for the daily download of engineering and science data, extracts and processes the telemetry data, and then displays it as a series of plots. One can see instantly what the spacecraft is up to and where it has been for the last few days.

The SWAS long-range planning tool can run detailed target visibility calculations a year or more ahead and present the results as web pages. Work is underway to make this tool interactive so that long-range schedules can be collaboratively built on-line.